PROGRESS REPORT No. 3
A STUDY OF STATE HIGHWAY NEEDS IN INDIANA

FEBRUARY, 1956
No. 4

Joint
Highway
Research
Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

by

H.L. Michael
and
D.O. Covault

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A STUDY OF STATE HIGHWAY NEEDS IN INDIANA

TO: K. B. Woods, Director
Joint Highway Research Project

February 1, 1956

File: 3-15
C-36-54T

FROM: Harold L. Michael, Assistant Director

Attached is Progress Report No. 3 on "A Study of State Highway Needs in Indiana." This report was prepared by Messrs. Harold L. Michael and Donald O. Covault of the Project staff. The assistance of numerous other members of the staff was also obtained in the preparation of many of the standards.

This report indicates the progress to date and presents some tentative tolerable and design standards that will be used for this study.

This report was also presented on December 29, 1955 to the Legislative Highway Study Commission of the State of Indiana, and received considerable discussion and review.

It is presented to the Board as information.

Respectfully submitted,

Harold L. Michael

Harold L. Michael, Assistant Director
Joint Highway Research Project

HLM:cjg

Attachment

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Progress Report No. 3

A Study of State Highway Needs in Indiana

by

Harold L. Michael, Assistant Director

and

Donald O. Covault, Research Engineer

Joint Highway Research Project

File: C-36-54T
3-15

Purdue University
Lafayette, Indiana

February 1, 1956

PROGRESS REPORT NO. 3 —— A STUDY OF STATE HIGHWAY NEEDS IN INDIANA

1. Background

The State Highway Needs Study was approved by the Advisory Board on September 9, 1954 and subsequently by the State Highway Department of Indiana. Since that time a great deal of study, work, and research has been done on this project as has been outlined in the two previous Progress Reports. Progress Report No. 3 will endeavor to bring you up-to-date as to the work that has been done on this project since our last report.

The rural ~~and~~ state highways in the State Highway System were completely inventoried in the winter and spring of this year. This inventory included all highway bridges, railway bridges, grade separation structures, and railroad crossings, in addition to information pertaining to the highways themselves. Most of this work was done by the State Highway Department of Indiana through the various Districts. The cooperation that the Joint Highway Research Project received from the various Districts during the inventory was excellent. The inventories as a whole were complete; however there were some errors found in them and they were returned to the Districts to be corrected. These inventories were promptly corrected and returned and we now have the information complete and are in the process of compiling it.

2. Coding of Inventory Data on IBM Cards

The information found on the 10,000 miles which compose the Indiana Highway System is now in the process of being placed on IBM cards. (For method of coding see Appendix of this report for "Instructions to Coders"

and a typical IBM layout sheet and IBM card.) The highway inventory was prepared and classified for coding as follows:

The inventory was taken in regard to road route number and maintenance section letter on a District basis. It was thought that this method of taking the inventory would be most complete since most records are based on this system.

Each maintenance section (which is usually from 1-10 miles in length) was broken down into a number of subsections based upon the following criteria:

1) A substantial change in traffic volume;
2) A change in the structural characteristics of the pavement, i.e., change in width, change in surface type, or a change from a rural pavement to an urban pavement;
3) The intersection of two or more state routes with each other.

Using the above criteria, most maintenance sections were broken into an average of 3 subsections and in some cases went as high as 9 subsections.

Essentially the following information was placed on the IBM cards:

1) Identification (route number, maintenance section number, etc.);
2) Structural characteristics of the pavement;
3) Rural state highway inventory;
4) Urban state highway inventory;
5) Highway bridge inventory;
6) Railroad crossing inventory;
7) Critical areas or sections of highways.

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This information was placed on several cards. The information in regard to the identification and structural characteristics of the pavement was placed on card No. 1. The rural state highway inventory or the urban state highway inventory information was placed on card No. 2. Each bridge in the particular subsection was placed on a separate card, as was each railroad crossing. Generally each subsection needed about 5 or 6 IBM cards.

The total estimate of IBM cards to be coded is about 15,000. The cards themselves will be punched, processed, and analyzed at the Statistical Laboratory here at Purdue.

The coding of this information has required the fulltime services of a number of people. Approximately 15 people are employed at present doing the clerical work required in the coding of this information. However, when the data is ready to be analyzed, various people trained in engineering and economics will be needed to evaluate the information.

The coding process was kept as uniform as possible by weekly meetings of various people on the staff and by criticisms and suggestions of various people involved in the processing of the information at the Statistical Laboratory.

Of course the information placed on the IBM cards is not as complete as the inventories themselves, but every effort was made to place the information on the IBM cards as accurately and as completely as possible. The IBM card generally will not answer specific questions about a certain area but will give a general picture as to what is found in each subsection. The information for bridges and railroad crossings, however, is generally specific and complete.

It will be necessary at the close of each year's construction season to reinventory all new construction and improvements that have taken place on the system during that year. In some cases a complete reinventory of the new construction (relocations, grade separations, etc.) will be required, while in other cases a slight change in the inventory information will be all that is needed (resurfacing, widening, etc.). When it is necessary to change the inventory data in a particular subsection or subsections, it is necessary to remove the old IBM cards and change the information that appears on them. The change may also involve changing the cards in the subsections adjacent to the area that has been rebuilt or improved. It can be seen that in order to keep the inventory up-to-date a yearly reinventory is necessary. The improvements and reconstruction for the 1955 construction season are being coded on the IBM cards here at Purdue. However, changes in inventory for the future years will be done by the Indiana State Highway Department.

The coding of the inventory information is about 50% complete, and will require a total of 5 months' work for the initial coding. It will be necessary to place many other items on the IBM cards after the initial inventory information has been coded, such as traffic information, finance, costs, etc.

3. Needs Study for County Road Systems

The Needs Study for Allen County in the state was completed by the Joint Highway Research Project in September of this year. The work was done by Mr. Baerwald of the staff and many good ideas and sugges-

tions resulted from his study. Mr. Baerwald set up a priority rating system for each road in Allen County. Using the factors of road rating vs service rating for each road, a plan for the improvement of the roads in Allen County was devised. In Table I, page 6, is shown a set of suggested design policies for rural county roads in Indiana that was determined as a direct result of this study. It is hoped that some of the ideas and methods that have been used in this study can be used to evaluate the needs for the Indiana State Highway System.

4. Traffic Trends

One of the basic indications of need on the State Highway System is traffic volumes and the rate of increase of these traffic volumes in relation to economic loss in delay, congestion, and accidents. Therefore, in order to adequately predict highway needs it is necessary to have an accurate picture of traffic volumes, the rate of increase of traffic volumes, and the character of the traffic which comprises these traffic volumes.

Information in regard to rural traffic volumes and rural traffic increases can be obtained with some degree of accuracy. However, information in regard to urban volumes and traffic trends is sadly lacking. The State Highway Department of Indiana has maintained 21 permanent traffic counters throughout the state that indicate some of the facts about traffic on rural highways. However, no information has been obtained on urban traffic. Therefore, it will be assumed that the rate of increase on the urban traffic is the same as the rate of increase of the state rural traffic. All indications are that this

TABLE I

DESIGN POLICIES FOR RURAL COUNTY ROADS IN INDIANA

THE JOINT HIGHWAY RESEARCH PROJECT
PURDUE UNIVERSITY
1954

ROAD CLASSIFICATION			LOCAL SERVICE		COUNTY SECONDARY		COUNTY PRIMARY	
HOURLY TRAFFIC VOLUME (VEHICS / 30th HIGHEST HR)			1 - 15		16 - 62		63 - 159	
AVERAGE DAILY TRAFFIC VOLUME (VEHICLES / DAY)			1 - 99		100 - 399		400 - 999	
			MINIMUM	DESIRABLE	MINIMUM	DESIRABLE	MINIMUM	DESIRABLE
DESIGN SPEED	(MILES / HOUR)	LEVEL	35	50	40	60	50	65
		ROLLING	30	45	35	50	45	55
		HILLY	25	35	30	40	40	45
PAVEMENT TYPE			MINIMUM 5" CRUSHED STONE OR GRAVEL	MINIMUM 8" CRUSHED STONE OR GRAVEL	MINIMUM 8" CRUSHED STONE OR GRAVEL	MINIMUM 12 CR ST OR GR (STABILIZED WHERE OVER 200 VPD)	PAVEMENT ON STABILIZED BASE	PAVEMENT ON STABILIZED BASE
MINIMUM WIDTH	(FEET)	RT OF WAY	40	60	50	80	60	100
		SHOULDER	4	5	5	6	6	8
		SURFACE	16	18	18	20	22	24
MINIMUM SIGHT DISTANCE (FEET)	STOPPING	LEVEL	240	350	275	475	350	540
		ROLLING	200	315	240	350	315	415
		HILLY	165	240	200	275	275	315
	PASSING	LEVEL	700	1400	900	2100	1400	2500
		ROLLING	500	1150	700	1400	1150	1750
		HILLY	300	700	500	900	900	1150
DEGREE AND RADIUS OF SHARPEST CURVE	(FEET)	LEVEL	18° 318	9° 637	14° 409	6° 955	9° 637	5° 1146
		ROLLING	25° 229	11° 521	18° 318	9° 637	11° 521	7° 819
		HILLY	36° 159	18° 318	25° 229	14° 409	14° 409	11° 521
MAXIMUM GRADIENT	(PERCENT)	LEVEL	10	7	8	6	7	6
		ROLLING	10	8	10	7	8	7
		HILLY	12	10	10	8	8	8
STRUCTURES		WIDTH (FEET)	18	22	20	24	24	28
		LOADING	10 T	15 T	10 T	15 T	15 T	20 T

is a reasonably correct assumption. On page 11 is a graph showing the actual and predicted rate of increase of traffic on the State Highway System in rural and urban areas. This graph was computed from data obtained from the 21 permanent traffic counters maintained by the State Highway Department throughout the state. It can be readily seen from this graph that the rate of increase of traffic on Indiana highways is approximately 5% a year. By the year 1976, the traffic volumes will approximately be double what they are in 1955. Indications are that these predictions may be conservative and that the traffic volumes will be greater than what is indicated on this chart.

Another method of predicting traffic trends is based on the growth or decrease in population, growth or decrease in motor vehicle registration, and growth or decrease in motor fuel consumption per vehicle. The net result of combining these three factors (population, motor vehicle registration, and motor fuel consumption per vehicle) is a graph showing the predicted percent increase in traffic. Figures 1, 2, and 3 on pages 8, 9, and 10 show these three factors for the state of Indiana and the resulting increase in traffic is shown on page 12.

Since the rate of increase of traffic for the three factor method is greater than the rate of increase of the data from the counters, the data from the counters shall be used in predicting traffic and the data obtained from the three factor method shall indicate the possible upper limit in the increase in traffic.

The character of the traffic volume is another important consideration in regard to needs on the Indiana highways. On state highways,

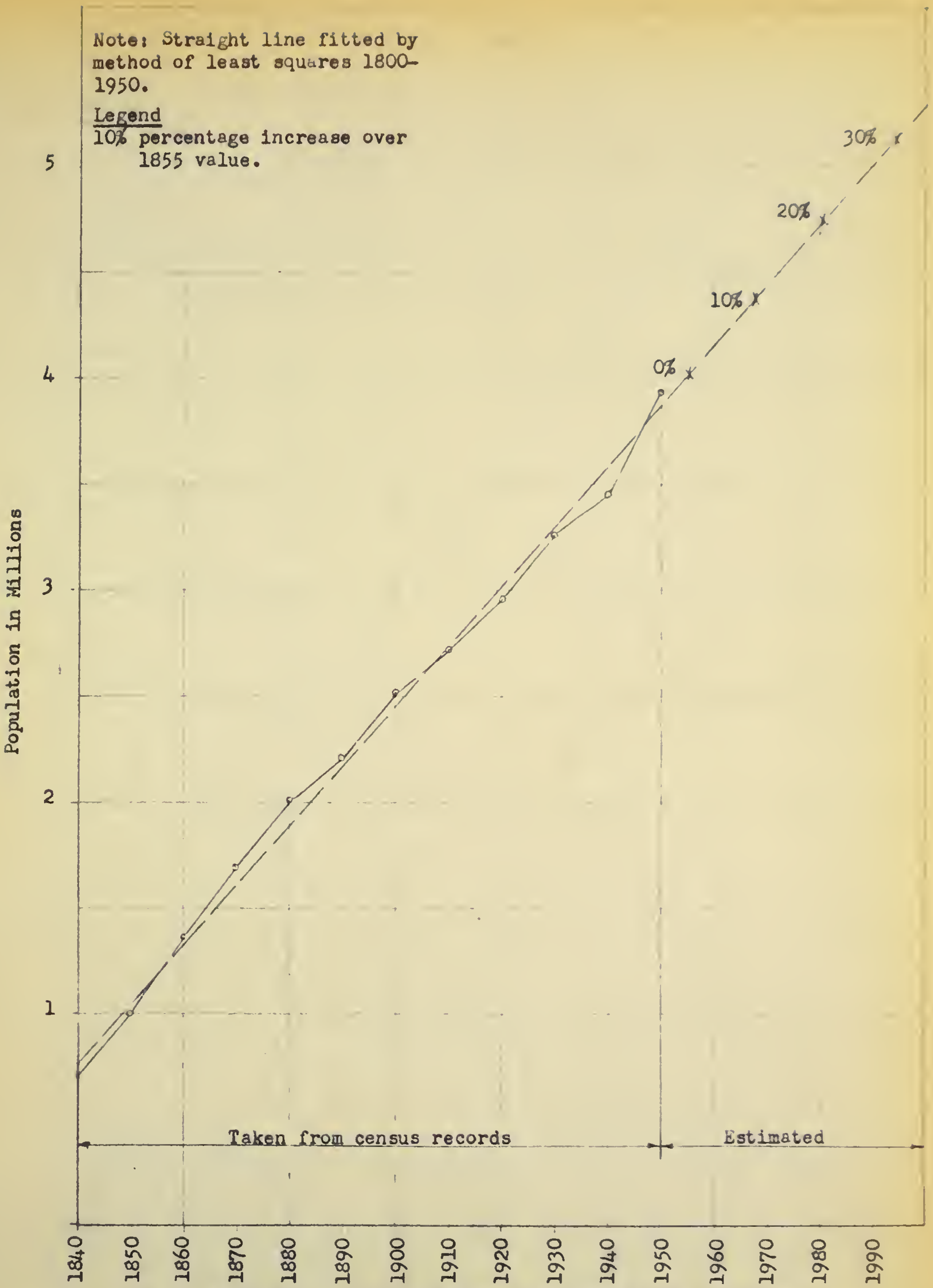

Figure 1. Actual and estimated population in Indiana

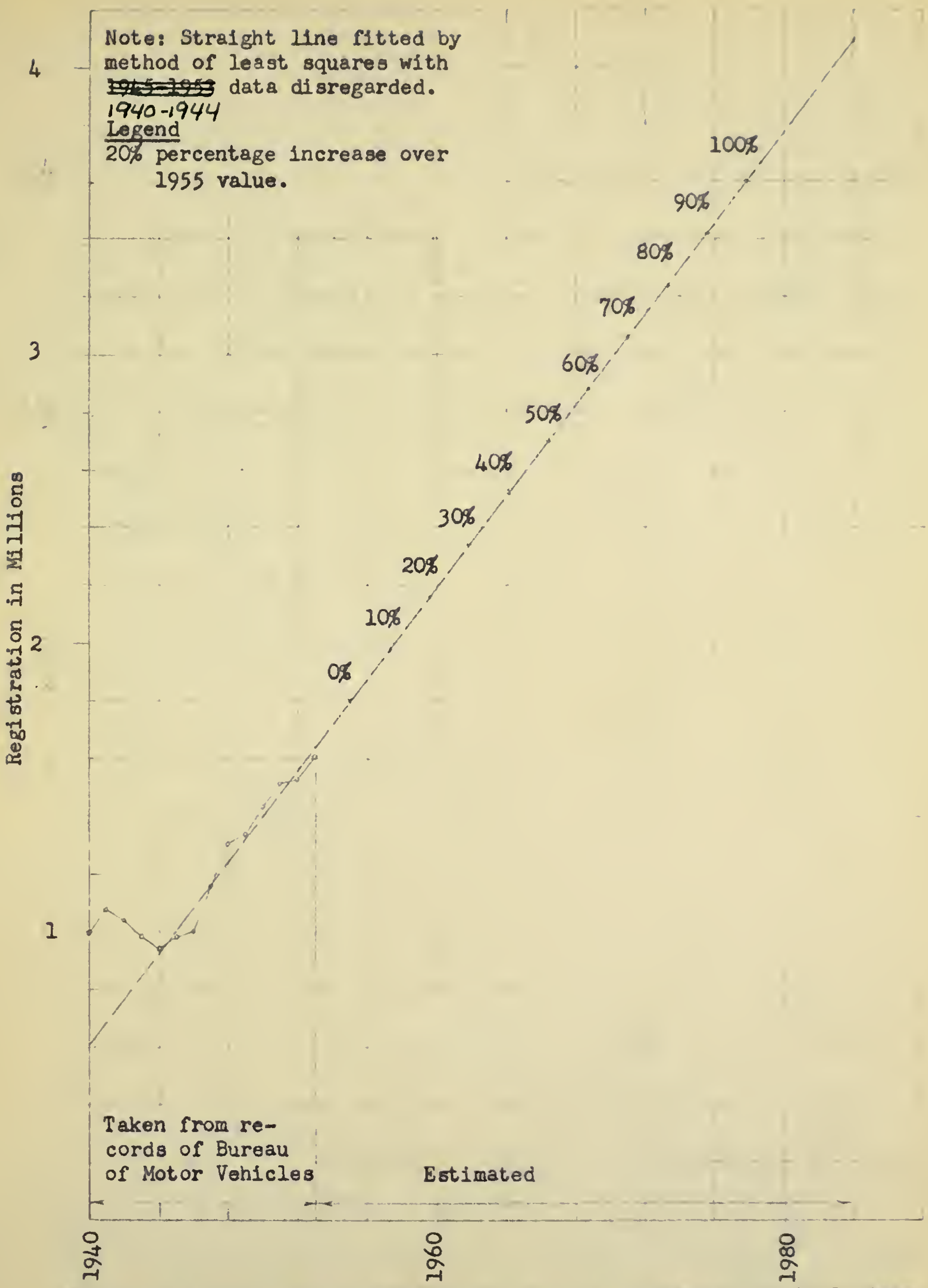

Figure 2. Actual and estimated motor vehicle registrations in Indiana

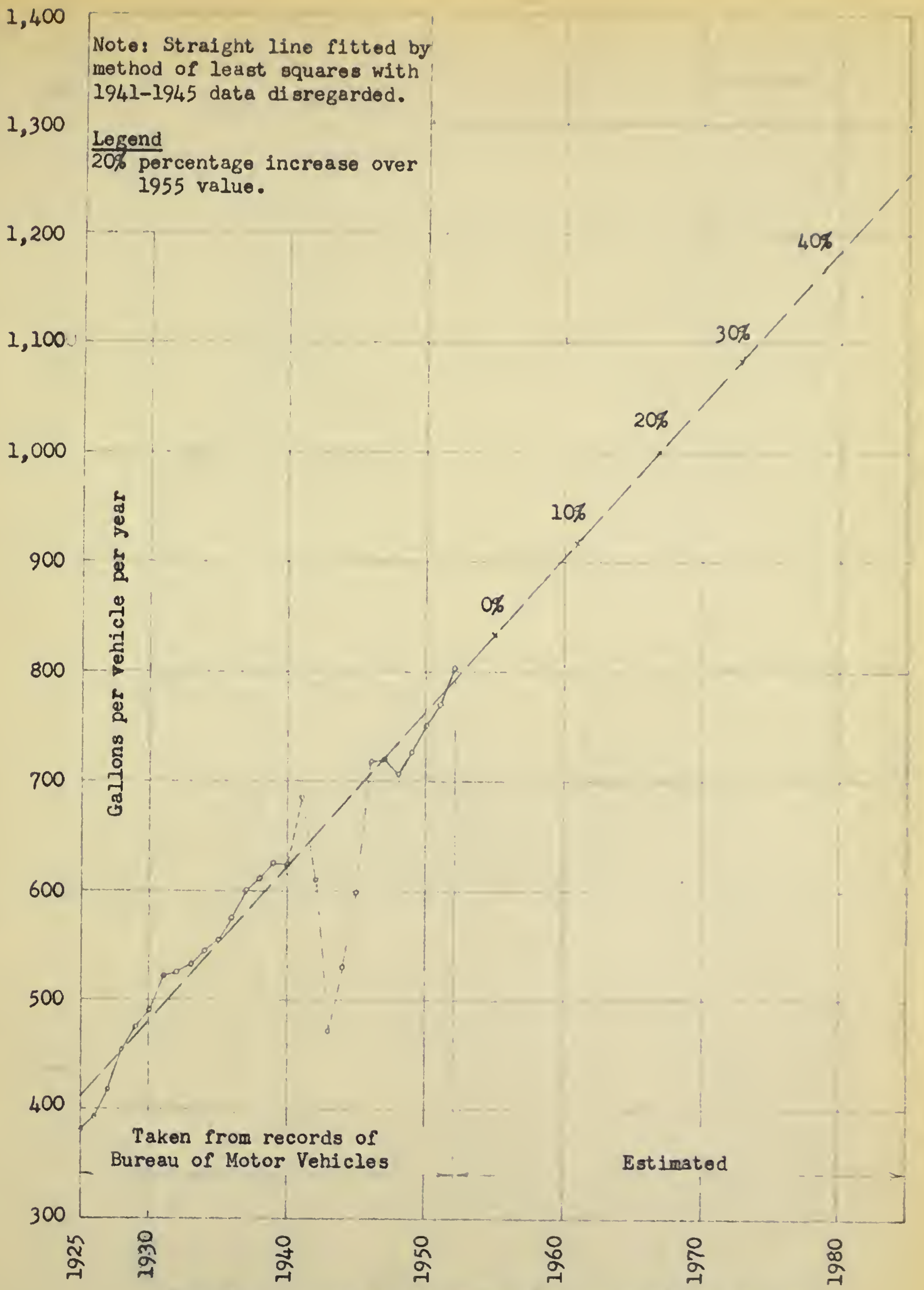

Figure 3. Actual and estimated fuel consumption per year.

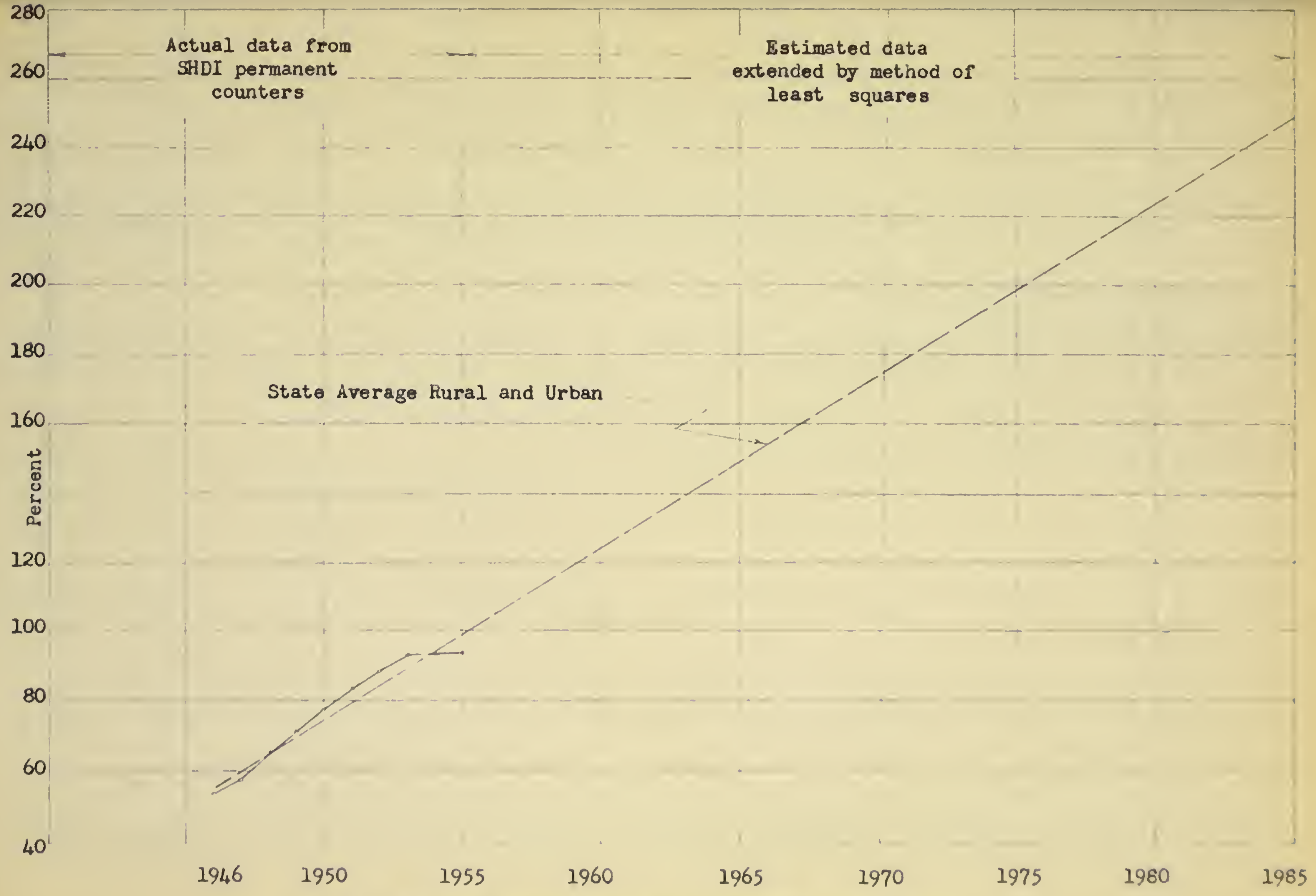

Fig. 4 Actual and estimated traffic volumes 1946 - 1985 expressed as percentage of 1955 average daily volume.

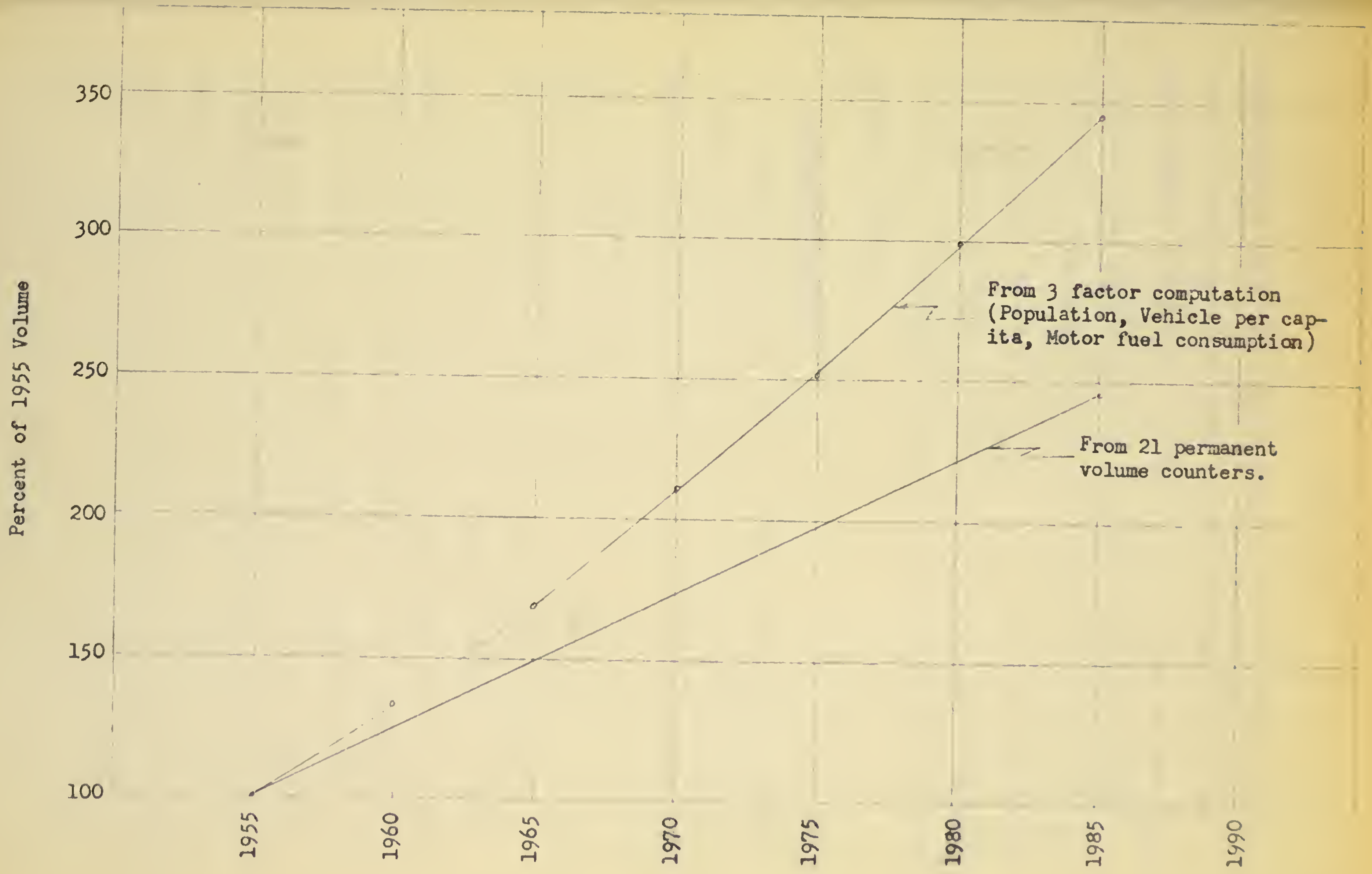

Figure 5. Estimated traffic volumes expressed as percentage of 1955 volumes.

approximately 80% of the traffic flow consists of passenger cars, while the remaining 20% consists of buses and light, medium, and heavy trucks. Indications are that the total percent of commercial vehicles in the traffic stream will remain essentially constant. However, the percent of increase in the medium and heavy trucks has been quite rapid over the past few years. As would be expected, most of the medium and heavy truck traffic is carried by the State Highway System here in Indiana, while county roads and local streets carry passenger vehicles.

5. Tolerable Standards

In Tables II and III, pages 17 and 18, are found the tolerable standards that have been set up for the interstate, state primary, and state secondary systems. It cannot be emphasized too strongly that these are minimum tolerable conditions and are not standards for new design. These are conditions which are to be tolerated for the present time and not conditions which are to be considered as adequate.

These standards will be used to determine immediate and future highway needs for the interstate and state systems. In each Table is outlined the minimum tolerable conditions that will be permitted for each classification of highway. Usually if a highway or bridge does not meet any one of these outlined conditions it will be considered intolerable. Generally, however, a highway will fail on a number of intolerable conditions instead of just one. There may be many cases where a highway barely meets tolerable conditions. In these cases and

other borderline cases, the particular highway will be referred to the Districts for further study and opinion.

Essentially the tolerable conditions that have been set up in Tables II and III are based on the three following factors:

a) Capacity of bridges and pavements - The capacity of pavements is greatly influenced by the following factors:

1) Operating speed
2) Topography
3) Restricted sight distance (passing sight distance less than 1,500')
4) Pavement and shoulder width
5) The percent of commercial vehicles in the traffic stream
6) Various other factors, of which "control of access" is a very important item.

It will be noted from these Tables that on the interstate and primary systems the minimum permissible lane width is 10' and that the minimum permissible shoulder widths are 5'. On the secondary state system the minimum permissible lane width is 9' and the minimum permissible shoulder width is 4'. The table of capacities is based upon the assumption of 20% commercial vehicles in the traffic stream.

The capacity of bridges is predominantly controlled by the curb-to-curb width of the bridge, railings, curb heights, and approaches to the bridge. For equal widths of road and bridge (curb-to-curb) the road approaching and leaving the bridge will have greater capacity than the bridge itself because of the psychological influence of railing and

and high curbs. When a vehicle crosses a bridge it has a tendency to move towards the center line and thereby reducing capacity.

b) Structural adequacy of pavements and bridges - There are many hundreds of miles of highways that were built 20 or 30 years ago that are structurally inadequate to carry present-day traffic and present-day loads. Many of these pavements were built on natural soil subgrades without stabilization and in many cases on subgrades which have poor supporting value. Considering the age of these pavements, the low supporting value of the soils on which they lay, and the extreme service that they have encountered throughout their life, it is not surprising that many are pumping, faulting, and showing many other signs of destruction and failure. A very good indication of the structural condition of the pavement is the relative cost of maintaining that pavement throughout its life. Many of the pavements today which are structurally inadequate are draining many thousands of dollars a year from the highway budget for maintenance procedures alone. In addition, other indications of structural adequacy are surface condition, surface type, and thickness and types of base material underlying the surface.

There are many thousands of bridges in the State Highway System that are structurally incapable of carrying heavy modern loadings. These bridges are the "weak links" in a good road system and therefore they must be replaced to maintain a system which is at least equal to the structural capacity of the road. Therefore, the minimum tolerable loading condition for bridges in the interstate and state primary system

is an H-15 loading or better, while in the state secondary system, the desirable minimum loading should be H-15. However, on those highways which carry few commercial vehicles, an H-10 loading will be considered tolerable. In addition, many other bridges are narrow, unsafe, and do not have adequate capacity to carry traffic. These bridges are also weak links in a good road system and therefore must be replaced or widened.

c) Safety - There are many pavements throughout the state which have a very high accident factor. Generally the 3-lane pavements and the 4-lane undivided pavements result in the greatest frequency of accidents. In some cases, however, other sections of seemingly safe highway have high accident factors. It will be necessary to study and analyze each area in which high accident rates are prevalent in order to intelligently determine whether this section of highway is intolerable or not. Generally for the interstate, state primary, and state secondary systems, a section of highway will be called intolerable if the accident rate is somewhat above the state average. Bridges which have high accident factors should be considered intolerable if the bridge itself is apparently the cause for a high accident rate.

Some of the probable predominant failures that will be found in each system are as follows:

1) In the interstate and state primary systems, a great number of pavements and bridges will be considered intolerable on the basis of capacity. A lesser number of these pavements and bridges will be structurally inadequate.

ABSOLUTE MINIMUM CONDITIONS ON EXISTING INTERSTATE HIGHWAYS (RURAL) AND PRIMARY STATE HIGHWAYS (RURAL) WHICH ARE CONSIDERED TOLERABLE FOR PRESENT TRAFFIC SERVICE

General Conditions:

1. Minimum lane width 10' (For 2, 3, or 4-lane highways.)
2. Minimum Shoulder width 5' (For 2, 3, or 4-lane highways.)
3. Control of access-partial (at least by permit)
4. Highway intersections-acceptable at grade.
5. Railroad crossings - separated for traffic volumes exceeding 5000 per day with 6 or more trains per day. All other crossings of main line tracks to have automatic signal protection. Spur tracks and main line tracks to have at least a flagman for protection.
6. Bridge loading H-15 or better.
7. Bridge width - minimum width of 22' or width of pavement.
8. Vertical clearance 13 ft.
9. Surface type - high type.
10. Surface condition - good condition required.
11. Roadway maintenance - not excessive.
12. Accident frequency not materially above state average.
13. Traffic volumes are those for 1955.

TOPOGRAPHY		FLAT & MODERATELY ROLLING			HILLY		
Maximum Curvature & Gradients		6°		6%	7°		7%
Stopping Sight Distance		475'			350'		
Operating Speed		45-50 MPH			40-45 MPH		
2 LANE HIGHWAYS		12'	11'	10'	12'	11'	10'
Max. 1955 ave. daily traffic	0%	5700	4900	4400	5200	4400	4000
	20%	5400	4700	4200	5000	4300	3900
Permissable with the following percents of restricted passing sight distance.	40%	5100	4400	3900	4800	4100	3700
	60%	4600	3900	3500	4400	3800	3400
	80%	3800	3300	2900	4000	3300	3100
	100%	3100	2600	2400	3500	3000	2700
3-LANE HIGHWAYS - USE VALUES FOR 2-LANE HIGHWAYS, MULTIPLY VOLUMES BY 1.5							
4-LANE HIGHWAYS LANE WIDTH		12'	11'	10'	12'	11'	10'
Max. 1955 daily traffic		20,000	19,000	18,000	19,000	18,500	17,500

ABSOLUTE MINIMUM CONDITIONS ON EXISTING SECONDARY STATE HIGHWAYS (RURAL) WHICH ARE CONSIDERED TOLERABLE FOR PRESENT TRAFFIC SURFACE

General Conditions:

1. Minimum width of lane 9'.
2. Minimum shoulder width 4'.
3. Control of access not required.
4. Highway intersections at grade acceptable.
5. Railroad crossings - separated when traffic exceeds 5000 per day with 6 or more trains per day; protected by automatic signals when highway traffic x trains per day exceeds 3500.
6. Bridge loading; H-15. If traffic contains a small number of commercial vehicles, H-10 may be used.
7. Bridge width - pavement width plus 2 ft. for traffic over 1000 vehicles per day. Bridge width for traffic less than 1000 vehicles per day shall be the same as the width of the pavement.
8. Vertical clearance - 13 feet.
9. Surface type - intermediate or high.
10. Surface condition - fair or better.
11. Surface maintenance - not excessive.
12. Accident frequency - not materially above state averages.
13. Traffic volumes for 1955. Use Table I for volumes above 3000.
14. Table based on two-lane highway.

TOPOGRAPHY	FLAT & MODERATELY ROLLING			HILLY		
1955 Average Daily Traffic	2000-3000	1000-2000	300-1000	2000-3000	1000-2000	300-1000
Lane width	10	9	9	10	9	9
Roadway width (including shoulders)	30'	28'	26'	30'	28'	26'
Surface type	High	Intermed.	Intermed.	High	Intermed.	Intermed.
Maximum curvature	7°	8°	9°	8°	10°	12°
Maximum gradient	7%	7%	8%	8%	9%	10%
Stopping sight distance	350	350	300	300	300	275

2) In the state secondary system, the greatest number of the pavement and bridges that are intolerable will be structurally inadequate. At present it is difficult to determine the total number of posted bridges throughout the state but most of these bridges will probably be found on the secondary system; therefore, this will be a very costly item in the reconstruction and maintenance of the system. Many of the roads and bridges in the secondary system will also be considered intolerable on the basis of capacity.

At the present time tolerable standards for urban areas have not been determined. It is very difficult to set up a set of tolerable standards for urban areas, since each city or local unit of government has its own procedures, policies, engineering methods, etc., for the respective highways and streets that pass through their city. The problem of determining tolerable standards is different in each city because of these differences in policies. However, the problem of determining tolerable standards for urban areas is under consideration and it is hoped by the time of the next Progress Report a more definite answer can be given.

6. Design Standards

Some of the general design concepts for highways in the interstate, state primary, and state secondary systems are as follows:

Because of the bad safety records of 3-lane and 4-lane undivided highways in this state, future design standards will not permit the construction of these types of highways. Therefore, 2-lane and 4-lane divided highways will be the general type of rural construction. Gen-

erally the grades and alignment of these highways will be designed on an indefinite period of time while the pavement will be designed on the basis of an economic life of 20-25 years. Therefore, the pavement will be designed for traffic volumes which will be anticipated within the next 20-25 years.

The general planning in regard to design, tolerable, and intolerable highways should be as follows:

The intolerable roads and bridges should be brought up to at least tolerable conditions within a certain period of time. Any additional construction will be the construction necessary to bring the tolerable conditions up to design standards. It can be readily seen that this general plan cannot be accomplished overnight or in a few years. It will probably require at least 20-30 years to bring the entire system up to design standards.

In Tables IV,and V, pages 22 and 23, are shown the design standards for the state primary and the state secondary systems. The interstate design standards are not shown since they have been definitely determined by the Federal Government and other agencies.

The State Highway Department under the supervision of Mr. Robert M. Brown is now in the process of making the preliminary designs for the 1,100 miles of the interstate system in Indiana. Some of the design features of the interstate highway system are as follows:

1) Divided multi-lane construction
2) Complete control of access
3) Separated highway intersections at all the more important road intersections

4) Separated railroad crossings

5) Wide bridges which are capable of carrying heavy loads

6) Wide right-of-way widths

7) Design speeds up to 70 mph.

8) Flat curves and low gradients

Mr. Brown's report on the cost and location of the interstate system is due in October of this year. It will be necessary for the Needs Study Group to coordinate their work with the interstate system study so that future planning will include the entire highway system. Additional meetings are planned with Mr. R. M. Brown and Mr. Tom Seward of the State Highway Department as the need arises in the coordination of the work. The design standards for the state primary and the state secondary systems have been definitely determined by various agencies, notably the American Association of State Highway Officials. Some of the important features of the new designs for the primary system are as follows:

1) Great many miles will be divided 4-lane highways

2) Complete control of access

3) Intersections of highways with substantial traffic volumes will be separated

4) Railroad crossings will be separated at points of substantial traffic

5) Wide bridges capable of handling heavy loads

6) Wide right-of-way widths

7) Flat curves and low gradients

STANDARD GEOMETRIC DESIGNS FOR NEW CONSTRUCTION ON PRIMARY STATE HIGHWAYS (RURAL)

General Design Features

1. Lane Width 12 Feet.
2. Shoulder Width 12 feet[1]
3. Control of Access - required.
4. Median Width on Divided Highways 16' min.
5. 1500' Passing Sight Distance for at least 20% of each mile on 2 lane highways.
6. Highway Intersections - Separated on 2-lane highways when total at intersections exceeds 5000 vehicles per day; on 4-lane highways when total exceeds 16,000 and cross road traffic exceeds 1000 vehicles per day; Grade separations shall be warranted under special considerations.
7. Railroad crossings - separated when highway traffic exceeds 3000 with more than 6 trains per day. All other crossings to be protected by automatic signals.
8. Bridge loadings - H20 - S16.
9. Bridge width under 100' long - full roadway; Over 100' long - pavement ≠ median ≠ 6 ft.
10. Vertical Clearance 14 t.
11. Surface Type - type 1, high type.

TOPOGRAPHY	FLAT AND MODERATELY ROLLING				HILLY			
Design Speed	70 MPH				60 MPH			
Operating Speed	50 to 55 MPH				45 to 50 MPH			
Stopping Sight Distance	600 ft.				475 ft.			
Maximum Curvature	3°				5°			
Maximum Grade	3%				6%			
Number of Lanes	2-Lanes			4-Lane Divided	2-Lanes			4-Lane Divided
Design Hour Volume 12½% Average Daily Traffic	370 to 420	260 to 370	under 260	480 to 1950	430 to 490	350 to 430	under 350	490 to 1950
1975 Average Daily Traffic	3000-3800	2100-3000	under 2100	15,500	3400-3900	2900-3400	under 2900	15,500
Maximum % restricted 1500 Passing Sight Distance	50%	70%	80%	-	40%	70%	80%	-
Minimum Right of Way	200	150	120	200	150	150	120	20

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[1] 10' ft. shoulders can be used when traffic volumes are less than 2000 vehicles per day.

STANDARD GEOMETRIC DESIGNS FOR NEW CONSTRUCTION ON SECONDARY STATE RURAL HIGHWAYS

General Design Features

1. Nearly all two lane highways (Use table for four lane.)
2. Control of access – partial control required.
3. Highway crossing at grade acceptable.
4. Railroad crossings – separated when highway traffic exceeds 4000 vehicles per day with 6 or more trains per day. All other main line crossings protected by automatic signals.
5. Highway intersections – separated on two lane highways when the total at the intersection exceeds 6000 vehicles per day.
6. Traffic volumes are those estimated for 1975.

TOPOGRAPHY	FLAT & MODERATELY ROLLING			ROLLING & HILLY		
Design Speed	60 MPH			50 MPH		
Operating Speed	45-50 MPH			35-40 MPH		
Stopping Sight Distance	475			350		
Design Hour Volume (12½% of Average Daily Traffic)	540-710	460-540		540-710	460-540	
1975 Average Daily Traffic	43-5500	27-4300	4-2700	43-5500	27-4300	4-2700
Maximum % of restricted 1500 Passing Sight Dist.	60%	80%	90%	80%	90%	90%
Surface Type	High	H.-Int.	H.-Int.	High	H.-Int.	H.-Int.
Lane Width	12'	11'	10'	11'	11'	10'
Shoulder Width	10'	10'	8'	10'	8'	8'
Maximum Curvature	4°	5°	6°	6°	7°	8°
Maximum Gradient	5%	6%	6%	6%	7%	7%
Minimum Right of Way	120	100	100	120	100	100
Bridge Loading	H20-S16	H15-S12	H15-S12	H20-S16	H15-S12	H15-S12
Bridge Width (Under 80' Long)	Full Roadway Width			Full Roadway Width		
Bridge Width (Over 80' Long)	Width of Pavement + 4 Ft.			Width of Pavement + 4 Ft.		
Vertical Clearance	14	14	14	14	14	14

8) Greater lane and shoulder widths

9) Design speeds up to 70 mph.

Some of the important features for new designs of the state secondary system will be as follows:

1) Nearly all will be 2-lane highways

2) In those areas of possible roadside development control of access will be required

3) More important highway intersections will be separated

4) More important railroad crossings will be separated

5) Flatter curves and lower gradients will be used than now exist on the secondary system

6) Generally, lane widths and shoulder widths should be wider

7) Bridge loading and bridge widths should be greater

8) Design speeds up to 60 mph.

As is the case with tolerable standards, design standards for urban areas have not been included. Again the design of urban streets depends a great deal upon the future development and problems of the particular urban area involved. It is impossible to state at this time what the design standards in urban areas should be. This problem is also under study and it is hoped by the next meeting of the Legislative Council that this problem will be solved.

7. General Comments

The Needs Study group has had the advice and counsel of several prominent men in the highway field; Mr. C. E. Fritts of the Automotive Safety Foundation has given us valuable advice and assistance. Mr. Fritts

met with several staff members of Purdue and the Joint Highway Research Project during the month of October, and at that time offered to help us with advice and counsel whenever it was needed. The cooperation of the State Highway Department of Indiana has been excellent, especially on the District level. Several members of the Joint Highway Research Project have devoted a great deal of their time to this project. Among them are Mr. A. K. Branham, Professor Paul Irick, Professor Harold L. Michael, and several other staff members. The cooperation of the main office of the State Highway Department in Indianapolis has also been excellent. Mr. Tom Seward and Mr. R. M. Brown have given excellent advice and have cooperated with us in many ways and have given us free access to their information.

The ideas presented in this report are for your suggestions and constructive criticism. It is suggested that a great deal of thought and discussion be given this report especially in regard to the determination of tolerable standards and design standards. These standards are one of the basic planning tools of the Highway Needs Study for the State System.

APPENDIX

INDIANA HIGHWAY NEEDS STUDY

INSTRUCTIONS TO CODERS

INDIANA HIGHWAY NEEDS STUDY

Prepared by

JOINT HIGHWAY RESEARCH PROJECT

Purdue University

October 22, 1955

GENERAL STATEMENT

The material that has been collected from an inventory of the State System of Indiana highways has been compiled on field sheets. These sheets are designated as follows:

(1) General Information and Data Sheet, Form S-1

(2) Rural State Highway Inventory Sheet, Form S-2-R

(3) Urban State Highway Inventory Data Sheet, Form S-2-U

(4) State Highway Bridge Inventory Data Sheet, Form S-3

(5) State Highway Railroad Protection Data Sheet, Form S-4

The inventory information that appears on these data sheets must be transferred to I.B.M. tabulation cards by assigning a code value or a code number for each item that appears on the inventory sheet.

The road inventory has been taken according to maintenance sections that have been designated for each district and road by the Indiana Highway Commission. Each maintenance section has been divided into a number of subsections based on the following criteria:

(1) A change in traffic volume

(2) A change in the structural characteristics of the pavement

(3) An intersection of two or more state routes.

In rural sections the subsection was determined by a change that was at least 0.5 mi. in length and in urban sections the subsections were determined by a change that was at least 0.1 mi. in length. Minor variations in the section did not influence the choice of the subsection.

The subsections were numbered consecutively from the beginning of the maintenance section on even numbered routes (west-east) from west to east and on odd numbered routes (south-north) from south to north. The majority of the road inventory data was taken in these directions also, but the direction was checked before subsections were numbered.

A set of I.B.M. cards is to be prepared for each subsection with the following information on the card:

(1) Identification

(2) Structural Characteristics of the pavement

(3) Rural State Inventory (Form S-2-R)

(4) Urban State Inventory (Form S-2-U)

(5) Highway Bridge Inventory (Form S-3)

(6) Railroad Protection Data

(7) Critical Areas

This information will be placed on several cards by the time it is completely recorded.

The inventory items will be coded on sheets designed for I.B.M. multiple card layout. Six cards can be placed on each sheet. Each card can accommodate 80 columns of data. The data for only one subsection is to be recorded on each sheet. When more than six cards are needed for a subsection, a second will be needed.

CODING

The following information is placed on the I.B.M. multiple card layout sheet before coding is started. The district number, route, maintenance section, and subsection number should be placed in the upper left hand corner. Example: An inventory in District number 20 (Fort Wayne District), State Route No. 1, maintenance section P, subsection 1 would be recorded as follows 2 - SR 1 - P - 1. The date and the project, "Needs Study," are also placed on the sheet. To insure accuracy, all coding will be independently checked.

Identification. This information is to be placed on all of the cards; however, it will only be necessary to record the identification information on card number 1 and the I.B.M. machine will punch the identical information on any other cards that are needed for the subsection. Nearly all of this information will be found on Form S-1.

(1) Project Identification, columns 1-2. No coding will be placed in this column since the I.B.M. machine will punch this information on the card. Indicate that the columns are blank by placing a large cross (X) mark across the two columns.

(2) State Highway District Number, column 3. The district number for each district shall be coded and placed on the sheet in the following manner:

District	Code No.
Crawfordsville - District 10	1
Fort Wayne - District 20	2
Greenfield - District 30	3
LaPorte - District 40	4
Seymour - District 50	5
Vincennes - District 60	6

(3) Route, columns 4, 5, 6, 7, and 8. Routes shall be recorded in the five columns provided. U.S. routes shall be coded "1" and State Routes shall be coded "2". These examples indicate how routes shall be coded.

Route Numbers (a) US 24
(b) SR 131A

1	0	2	4	-
2	1	3	1	A
4	5	6	7	8

Column number 8 shall be used for the letter designation found on the end of some route numbers; a dash shall be used if none exists. Blank spaces shall have the number 0 placed in them.

(4) Maintenance Section, columns 9, 10, and 11. The Maintenance Section should be coded according to one of the following examples: Letter Designations that are not needed are recorded as dash and number

Maintenance Section (a) PP1
Numbers (b) P

P	P	1
-	P	0
9	10	11

designations that are not needed are recorded as 0.

(5) County, columns 12 and 13. The 92 counties in Indiana have been coded alphabetically from 01 to 92. Please place the appropriate numbers in columns 12 and 13 as indicated (see Indiana County Codes).

County (a) Adams 01
(b) Owen 61

0	1
6	1
12	13

(6) System, column 14. The systems of highways shall be broken into the following classifications:

System	Code
Interstate	1
Primary	2
Secondary	3
Urban	4
Other Federal	5
Non-Federal	6

Urban streets that are on the interstate systems shall be classified as interstate.

(7) Number of the Subsection, columns 15-16. Subsection numbers are marked in red on Forms S-2 along with the subsection length and cumulative mileage to the beginning of the subsection. The number of the subsection shall be placed in column 15, and if the lanes of traffic are undivided, the number 0 shall be placed in column 16. If the subsection refers to the left lane of a divided highway, the code number 1 shall be used; if the subsection refers to the right lane of a divided highway, the code number 2 shall be used. The following example illustrates the method of recording:

Subsection Numbers			
	(a) 2	2	0
	(b) 4 Right	4	2
		15	16

Structural Characteristics of the Pavement. This information is to be placed on card number 1 and will not appear on any other card as does the Identification information. This data will be found on Forms S-1 and S-2.

(8) Location and Length of Subsection, columns 17, 18, 19, 20, 21, 22 Columns 17, 18 and 19 shall be used to locate the beginning of each subsection from the beginning of the maintenance section (mile 0.0) to the nearest 0.1 of a mile. Columns 20, 21 and 22 shall be used for the length of the subsection to the nearest 0.1 of a mile.

Subsection No.	Location	Length						
(a) 1	0.7	0.2	0	0	7	0	0	2
(b) 4	7.9	5.2	0	7	9	0	5	2
			17	18	19	20	21	22

as sample of the method of recording is indicated.

(9) Number of Traffic Lanes, column 23. The traffic lanes shall be codes as follows:

Number of Lanes	Code
1	1
2	2
3	3
4	4
5	5
6	6

INDIANA NEEDS STUDY

COUNTY CODE

Adams	01	Lawrence	47
Allen	02	Madison	48
Bartholomew	03	Marion	49
Benton	04	Marshall	50
Blackford	05	Martin	51
Boone	06	Miami	52
Brown	07	Monroe	53
Carroll	08	Montgomery	54
Cass	09	Morgan	55
Clark	10	Newton	56
Clay	11	Noble	57
Clinton	12	Ohio	58
Crawford	13	Orange	59
Daviess	14	Owen	60
Dearborn	15	Parke	61
Decatur	16	Perry	62
DeKalb	17	Pike	63
Delaware	18	Porter	64
Dubois	19	Posey	65
Elkhart	20	Pulaski	66
Fayette	21	Putnam	67
Floyd	22	Randolph	68
Fountain	23	Ripley	69
Franklin	24	Rush	70
Fulton	25	St. Joseph	71
Gibson	26	Scott	72
Grant	27	Shelby	73
Greene	28	Spencer	74
Hamilton	29	Starke	75
Hancock	30	Steuben	76
Harrison	31	Sullivan	77
Hendricks	32	Switzerland	78
Henry	33	Tippecanoe	79
Howard	34	Tipton	80
Huntington	35	Union	81
Jackson	36	Vanderburgh	82
Jasper	37	Vermillion	83
Jay	38	Vigo	84
Jefferson	39	Wabash	85
Jennings	40	Warren	86
Johnson	41	Warrick	87
Knox	42	Washington	88
Kosciusko	43	Wayne	89
LaGrange	44	Wells	90
Lake	45	White	91
LaPorte	46	Whitley	92

(10) Type of Median, column 24. Median type shall be coded as follows:

Type of Median	Code
Raised Concrete	1
Depressed Concrete	2
Raised Earth	3
Depressed Earth	4
Raised Concrete & Earth	5
Depressed Concrete & Earth	6

If no median exists, blank out by using a large cross-mark (X) columns 24, 25, and 26.

(11) Width of Median, columns 25-26. Width shall be indicated to the nearest foot. A width of 99 feet shall indicate a median whose width is equal to 99 feet or over.

(12) Surface Type (1st Component), column 27. The road surface type shall be designated according to the following codes:

Surface Type	Code
Gravel or Crushed Stone	1
Plain Cement Concrete	2
Reinforced Cement Concrete	3
Rock Asphalt	4
Bituminous Concrete	5
Bituminous Coated Aggregate	6
Bituminous Surface Treatment	7
Bituminous Retread Surface	8
Road Oil Mat	9
Unknown and other	0

(13) Surface Thickness, columns 28-29. The thickness of portland cement concrete surfaces shall indicate the edge thickness and center thickness. For example, a concrete pavement that has an edge thickness of 9 inches and a center thickness of 7 inches will be recorded as 97

in the coding. The thickness of bituminous concrete pavement shall be indicated to the nearest 0.5 inch. If the surface thickness is unknown record 0 in columns 28 and 29. The sketch shown illustrates how the coding should be recorded:

(a) Concrete edge 9" thick, edge 7" thick.

(b) Bituminous concrete 4.5" thick

9	7
4	5
28	29

(14) Surface Width, columns 30 and 31. The width shall be recorded to the nearest foot. Those with variable widths shall be indicated by an "x" punch, and the predominate width recorded. The "x" punch shall be placed over the digit in column 31. The example shown illustrates how the width shall be recorded:

(a) Concrete width 24'.

(b) Bituminous concrete predominate
width 22'.

2	4
	x
2	2
30	31

(15) Surface Year Built, columns 32 and 33. The last two digits of the year year shall indicate the year the surface type was built. If the year is unknown, place 00 in the columns.

(a) Year 1926

(b) Year 1932

2	6
3	2
32	33

(16) Binder (2nd Component), columns 34 to 37. If no binder exists, cross out columns 34, 35, 36 and 37. The binder course shall be always bituminous concrete and therefore the material will not be coded.

(17) Binder Thickness, columns 34 and 35. Record the thickness to the nearest 0.5 inch similarly to the method indicated under item 13. If the thickness is unknown record 0 in columns 34 and 35.

(18) Binder Year Built, columns 36 and 37. The last two digits of the year that the binder was built shall be indicated in columns 36 and 37, in the same manner as for item 15. If the year built is unknown, use 0 in these columns.

(19) Intermediate Layer (3rd Component), column 38. If no Intermediate layer exists, cross out columns 38, 39, 40, 41, and 42. The intermediate layer or 3rd component shall consist of materials or surfaces that have been placed on the road during its lifetime as a part of stage constructions. The intermediate layer shall be one of several materials as is hereby difined:

Materials	Code
Portland Cement Concrete	1
Bituminous Concrete	2
Road Oil Mat or Surface Treatment	3
Unknown	9

(20) Thickness of Intermediate Layer, columns 39 and 40. The thickness of the intermediate layer shall be indicated to the nearest 0.5 inch, similarly to the method used for surface thickness under item 13.

(21) Intermediate Layer Year Built, columns 41 and 42. The last two digits of the year built shall be indicated in these columns. It should be coded in the same manner as for item 15. If the year is unknown, use 00 in these columns.

(22) Base Component (4th Component), column 43. If no base component exists, cross out columns 43, 44, 45, 46, 47, 48 and 49. In most cases, the base component will be the lowest structural element of the road. The type of base shall be coded as follows:

Materials	Code
Portland Cement Concrete	1
Bituminous Concrete	2
Brick	3
Soil Cement	4
Waterbound Macadam	5
Old County Road (old gravel base)	6
Unknown	9

(23) Thickness of the Base Component, columns 44 and 45. If the principal component is concrete, the edge and center thickness shall be recorded similar to the method that was used for surface thickness under item 13. Thickness of all other materials shall be recorded to the nearest 0.5 inch. If thickness is unknown, record 0 in columns 44 and 45.

(24) Width of Base Component, columns 46 and 47. The width shall be recorded to the nearest foot as in item 14.

(25) Year Base Component Built, columns 48 and 49. The last two digits of the year that the base component was built shall be recorded in the same manner as item 15. If the date is unknown, use 00 in these columns.

(26) Subgrade Treatment (5th Component), column 50. If no subgrade treatment exists, cross columns 50 and 51. The following types of subgrade treatment shall be used:

Type	Code
Salt Stabilization	1
Asphaltic Oil or Tar Stabilization	2
Soil Granular Material Mixture	3
Sand Course	4
Gravel or Crushed Stone	5
Gravel or Crushed Stone on Sand	6
Unknown	9

(27) Thickness of Subgrade Treatment, column 51. The total thickness of the subgrade treatment shall be indicated to the nearest 1 inch. If the thickness is unknown, record 0 in column 51.

(28) Overall Field Rating, column 52. The overall field rating appearing at the bottom of the General Information and Data Sheet shall be placed in column 52.

This item completes the inventory data that will appear on card number 1. Additional information of a different nature will be placed in columns 53 to 80 at a later date.

RURAL INVENTORY DATA SHEET

The information that appears on the rural inventory data sheet will be coded on I.B.M. Card number 2. If no rural inventory exists, the section is urban and the inventory data for the section shall be recorded on Card No. 2. Columns 1-16 on Card No. 2 are to be used for the Identification information that appears on Card No. 1. This information will be punched on Card No. 2 by the I.B.M. machine from the coding that appears in columns 1-16 on Card No. 1. Do Not fill in these columns.

Cultural Items

(1) Recreation, column 17. Enter the total number of recreation items found in a subsection in column 17. If more than 9 items are recorded, place the number 9 in column 17. Therefore the number 9 will be represent "9 or more" items of recreation in the subsection. The following example illustrates how this should be coded:

(a) 5 Items
(b) 9 Items
(c) 11 Items

5
9
9
17

(2) Churches, column 18. The total number of churches in each subsection shall be recorded in column 18. The number 9 shall mean "9 or more" in the particular subsection.

(3) Schools, column 19. The total number of schools in each subsection shall be recorded in column 19. The number 9 shall mean "9 or more" in the subsection.

(4) Business Establishments, columns 20-21. Enter the total number of business establishments in the subsection in columns 20 and 21. If the number of business establishments is 99 or more, the number 99 shall be recorded in columns 20 and 21. The following example illustrates how the coding shall be done:

(a) 5 Business Establishments
(b) 22 " "
(c) 121 " "

0	5
2	2
9	9
20	21

(5) Industrial Plants, column 22. The total number of industrial plants shall be recorded in each subsection. The number 9 shall represent 9 or more plants in the subsection. This information shall be coded in the same manner as was Item 1

(6) Non Farm Dwellings, columns 23, 24. The total non-farm dwellings for each subsection shall be recorded in columns 23 and 24. If the number of non-farm dwellings is 99 or more, the number 99 shall be recorded in columns 23 and 24. The information shall be recorded in the same manner as was in Item 3.

(7) Farm Dwellings, columns 25, 26. The total number of farm dwellings for each subsection shall be recorded in columns 25 and 26. The number 99 shall be recorded if the number of farm dwellings is 99 or more. The information shall be recorded in the same manner as Item 3.

(8) Highway Entrances, Left, columns 27, 28. Highway Entrances Right, 29, 30. The number of highway entrances left of the direction of survey shall be recorded in columns 27 and 28. The number 99 shall be recorded if the number of entrances is 99 or more. The number of entrances on the right shall be recorded in the same manner as the entrances on the left. The following example illustrates how the coding shall be done:

(a)	Left	25 entrances	2	5
(b)	Left	107 entrances	9	9
			27	28

(a)	Right	3 entrances	0	3
(b)	Right	21 entrances	2	1
			29	30

(9) Right-of Way, column 31, 32, 33. The predominant width (not the average) of right-of-way for each subsection shall be recorded to the nearest foot. If an area in the subsection has a critical right-of-way width, smaller than the predominant width, column 33 shall be "x" punched over the digit pertaining to the right-of-way widths that will appear there. The following criteria shall be used to determine critical sections.

Rural Sections	Urban Sections
Critical Right-of-way width 50 feet and under	Critical Right-of-way width 40 feet and under

The subsection cards shall not be "x" punched if the entire subsection is critical. The "x" punch shall be used to indicate areas where a critical area exists and not in subsections where the entire subsection is critical; the critical width will only be recorded. The following example illustrates the method of coding:

(a) Predominant width 70 feet (rural areas)

0	7	X 0
31	32	33

(b) Width 35 feet (urban)
(c) Width 170 feet

0	3	5
1	7	0
31	32	33

(10) Width of Shoulder, Left columns 34, 35. Width of shoulder, Right columns 36, 37. The width of left shoulder shall be recorded in columns 34 and 35 to the nearest one foot, and the width of the right shoulder shall be recorded in columns 36 and 37 to the nearest one foot. The following example illustrates how this information shall be coded.

(a) Left, 5 foot shoulder
(b) Right, 13 foot shoulder

0	5	1	3
34	35	36	37

When widths vary in a subsection, predominant widths (not average) widths shall be coded.

(11) No-Passing Zone Left, columns 38, 39. No-Passing Zone Right 40, 41. The total length (to the nearest tenth of a mile) of the no-passing zones left and right in each subsection shall be indicated. The following example illustrates the method of coding.

(a) Length of No-Passing zones left 1.2 mi.

(b) Length of No-Passing zones right 0.9 mi.

1	2	0	9
38	39	40	41

(12) Speed Zoning, columns 42, 43, 44, 45. The total length (to the nearest tenth of a mile) of speed zones shall be indicated in the following categories;

Speed (MPH)	Columns
45-60	42, 43
40 and under	44, 45

(a) Zoned Speed 45-60 MPH, 1.6 miles,
(b) Zoned Speed 40 and under 0.3 miles

1	6	0	3
42	43	44	45

When no speed zone exists use number 00.

(1[illegible]) Culverts (Span Length under 20 feet), columns 46, 47, 48, 49, 50, 51. Culverts shall be divided into three groups according to their field conditions: good, fair, and poor condition. All culverts shall be considered in poor condition if the field rating is poor, or if the overall length of the culvert is less than 36 feet, or if the distance between protruding headwalls is less than 36 feet. The total number in each category shall be recorded in each subsection as is illustrated by the following example:

(a)	Good	14
(b)	Fair	7
(c)	Poor	2

1	4	0	7	0	2
46	47	48	49	50	51

Use number 00 for each culvert that does not fall into one of the above classifications. Anything less than 18 in. in diameter will be considered to be poor.

Condition

The condition ratings for each subsection shall be the average condition. The average shall be found by estimating the mean by "scanning" the condition ratings for each item. An "x" punch shall be used for those subsections which contain some critical sections. The critical sections shall not be included in the determination of the average condition. An "x" punch shall not be used if the entire subsection is critical.

(1) Median, column 52. The condition rating for the median shall be done according to the following code.

Condition	Code
None	0
Excellent	1
Good	2
Fair	3
Poor	4

Use an "x" punch over the code number if any critical conditions exist. If the entire subsection is critical (rating of 4) no "x" punch shall be used. The following example illustrates the method of coding:

(a) Rating of 2
critical turns in subsections

x
2
52

(b) Rating of 4
(entirely critical)

4
52

(2) Surface Riding Quality, column [illegible]. The quality of the riding surface shall be coded as illustrated. Use an "X" punch over the code number if critical conditions exist. If the entire subsection is critical (rating of 4), no "X" punch shall be used.

Surface Riding Quality	Code
Excellent	1
Good	2
Fair	3
Poor	4

(3) Base Failure, Flexible Pavements, column 54. The base failure for flexible pavements shall be rated and coded as follows:

Condition	Code
Slight (0-2% area)	0
Medium (3-15% area)	1
Extensive (16-30% area)	2
Critical (Over 30% area)	3

All critical areas shall be indicated with an "X" punch. If the entire subsection is critical (rating of 3), no "X" punch shall be used.

(4) Base Failure, Rigid Pavement. Base failure for rigid pavements shall be rated similar to the base failure for flexible pavements. The coding shall be as follows:

Condition	Code
Slight	0
Medium	1
Extensive	2
Critical	3

If the subsection contains critical areas, place an "X" punch over the code number. If the entire subsection is critical, no "X" punch shall be used.

(5) Surface Failure, column 55. Surface failure for pavements shall be rated and coded as follows:

Slight (0-2%)	0
Medium (3-15%)	1
Extensive (16-30%)	2
Critical (Over 30%)	3

If the subsection contains critical areas, place an "X" punch over the code number. If the entire subsection is critical, no "X" punch shall be used.

[illegible] [illegible] [illegible] [illegible] shall be coded as follows:

Condition	Code
Excellent	[illegible]
Good	[illegible]
Fair	[illegible]
Poor	[illegible]

The following example illustrates the manner in which shoulder condition shall be coded:

(a) Shoulders left, condition rating 3, some critical areas.

[illegible]

(b) Shoulders Right, condition excellent.

[illegible]

Critical areas, (rating of 4), in this subsection shall be indicated as previously described.

(7) Highway Drainage, column 58. The condition rating for highway drainage should be coded as follows:

Condition	Code
Excellent	1
Good	2
Fair	3
Poor	4

All critical areas, (rating of 4) in subsections shall be recorded as was previously described.

(8) Horizontal Alignment, column 59. The horizontal alignment shall be coded according to the amount of curvature. The alignment shall be coded as follows:

Frequency of Curves	Code
None	0
One curve	1
Two to continuous curving	2
Continuous curves	3
Continuous curves, more than ½ critical	4

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]		[illegible]

[illegible]

[illegible]	Code
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible]	Code
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

(iii) Topography, column (2 [illegible]

Topography	Code
[illegible]	[illegible]
Rolling	[illegible]
Hilly	[illegible]

URBAN STATE HIGHWAY INVENTORY DATA SHEET

The data that appear on the urban state highway inventory data sheet shall be coded on I.B.M. card number 2. If no urban inventory exists, the subsection is rural and the inventory data shall be recorded on card number two. Columns 1 - 16 on Card No. 2 are to be used for the Identification information that appears on Card No. 1. This information will be punched on Card No. 2 by the I.B.M. machine from the coding that appears in columns 1 - 16 on Card No. 1. Do Not Fill in These Columns

Cultural Items

(1) Recreation, column 17. Enter the total number of recreational items in each subsection in column 17. If more than 9 items are recorded, place number "9" in column 17. Therefore, the number 9 will represent "9 or more" items of recreation in the subsection. The following example illustrates how this shall be coded:

	17
(a) 5 items	5
(b) 9 items	9
(c) 11 items	9

(2) Churches, column 18. The total number of churches in each subsection shall be recorded in column 18. The number 9 shall represent "9 or more" in the particular subsection

(3) Schools, column 19. The total number of schools in each subsection shall be recorded in column 19. The number 9 shall mean "9 or more" in the particular subsection.

(4) Business Establishments, columns 20, 21. The total number of business establishments shall be entered in columns 20 and 21. If there are "99 or more" the number 99 shall be recorded. The following example illustrates how the coding shall be done:

(a)	10 business establishments	1	0
(b)	3 business establishments	0	3
(c)	102 business establishments	9	9
		20	21

(5) Industrial plants, column 22. The total number of industrial plants shall be recorded in each subsection. The number 9 shall represent "9 or more" plants in the subsection. This information shall be recorded in the same manner as was item 1 (recreation.).

(6) Houses, columns 23, 24. The total number of houses in each subsection shall be recorded similarly to item No. 4 (Business establishments), The number 99 shall represent "99 or more" houses in the subsection.

(7) Apartments and Hotels, columns 25, 26. The total number of apartments and hotels in each subsection shall be recorded. The number 99 shall represent "99 or more" apartments or hotels.

(8) Highway Entrances, Left 27, 28; Right columns 29, 30. The number of highway entrances to the left or right of the direction of survey shall be recorded. The number 99 shall represent "99 or more" entrances. The following example illustrates how the coding shall be done:

(a)	Left	2 entrances	0	2
(b)	Left	103 entrances	9	9
			27	28

(a)	Right	21 entrances	2	1
(b)	Right	73 entrances	7	3
			29	30

(9) Width of Right of Way, columns 31, 32, and 33. The predominant width (not the average) of right of way for each subsection shall be recorded to the nearest foot. If an area in a subsection has a critical right of way width, smaller than the predominant width, column 33 shall be "x" punched over the digit pertaining to the right of way width that will appear there. A right of way width 40 feet and under in an urban area shall be considered critical. The right of way width shall not be "x" punched if the entire

subsection is critical; the critical width will only be recorded. The following example illustrates how the coding shall be done:

(a) Predominant width 60 feet; some critical area or areas.

		x
0	6	0

(b) Width 40 feet
(c) Width 90 feet

0	4	0
0	9	0
31	32	33

(10) Curbs, Left columns 34, 35; Right columns 36, 37. The total length of curbs left and right of the direction of survey shall be recorded to the nearest tenth of a mile. The method of recording is illustrated as follows:

(a) Length of Curb, Left 7.6 miles

(b) Length of Curb, Right 0.2 miles

7	6	0	2
34	35	36	37

(11) Sidewalks, Left columns 38, 39; Right columns 40, 41. The length of sidewalks left and right of the direction of survey shall be recorded to the nearest tenth of mile. The method of recording shall be similar to the recording of "curbs" under item 10.

(12) Parking Limitations, Left columns 42, 43; Right columns 44, 45. Indicate the total length of restricted parking to the left and right of the direction of survey to the nearest tenth of a mile. Peak hour and continual limit parking shall be considered restricted parking.

(13) Type of Parking, Left column 46; Right column 47. Indicate the type of parking allowed on each side of the highway in each subsection according to the following code:

Type of Parking	Code
None	0
Parallel	1
Diagonal	2
Parallel and Diagonal	3

(14) One-Way Operation, column 48. Indicate whether the street is operated as a one-way street by the following code:

One-Way Operation	Code
Yes	1
No	2

(15) Number of Intersecting Streets, Left columns 49, 50; Right columns 51, 52. The total number of intersecting streets left and the total number of intersecting streets right shall be recorded: A "cross street" shall be counted as two intersections, one to the left and one to the right. The following example illustrates the method of recording:

(a) Intersections, 21 Left
(b) Intersections, 5 Right

2	1	0	5
49	50	51	52

(16) Traffic Control Devices, columns 53, 54. The number of traffic control devices (traffic signals only) in each subsection shall be recorded in columns 53 and 54. The following example illustrates the method of coding:

(a) 2 Traffic Control Devices

(b) 11 Traffic Control Devices

0	2
1	1
53	54

CONDITION

The condition rating for each subsection shall be the "average" condition. It shall be determined by "scanning" the condition ratings for each item in the subsection and determining an average. An "X" punch shall be used for those subsections which contain critical areas. The critical areas shall not be included in the determination of the average conditions. An "X" punch shall not be used if the average condition is critical for the subsection

(1) Median, column 55. The average condition rating of the median shall be determined and recorded according to the following code. Use an "X" punch over the code number if any critical condition exists. If the average subsection condition is critical (rating of 4), no "X" punch shall be used.

Condition	Code
None	0
Excellent	1
Good	2
Fair	3
Poor	4

The coding shall be completed according to the following example:

(a) Rating of 2; critical item in subsection	X 2 55
(b) Rating 4 (average is critical)	4 55

(2) Surface Riding Quality, column 56. The surface riding quality shall be coded as illustrated. Use an "X" punch over the code number if critical conditions exist. If the average condition is critical (rating of 4), no "X" punch shall be used.

Surface Riding Quality	Code
Excellent	1
Good	2
Fair	3
Poor	4

(3) Base Failure Flexible or Rigid Pavements, column 57. The base failure for flexible pavements shall be rated and coded as follows:

Condition	Code
Slight (0-2% Area)	0
Medium (3-15% Area)	1
Extensive (16-30% Area)	2
Critical (Over 30% Area)	3

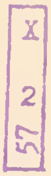
The base failure for rigid pavements shall be rated similar to the base failure for flexible pavements. The coding shall be as follows:

Condition	Code
Slight	0
Medium	1
Extensive	2
Critical	3

If the subsection contains critical areas, place an "X" punch over the code number. If the average condition is critical, no "X" punch shall be used. The following example illustrates the method of coding:

(a) Base Failure, Condition rating 2

Some critical areas



(4) Surface Failure, column 58. The surface failure shall be recorded according to the following code:

Condition	Code
Slight (0-2% Area)	0
Medium (3-15% Area)	1
Extensive (16-30% Area)	2
Critical (over 30%)	3

All subsections which contain critical areas shall be "X" punched. If the average condition is critical, no "X" punch shall be used.

(5) Highway Drainage, column 59. The condition rating for highway drainage shall be coded as follows:

Condition	Code
Excellent	1
Good	2
Fair	3
Poor	4

All critical areas in the subsection shall be recorded as was previously described.

(6) Gradient, column 60, The grade line of the road shall be coded according to the following condition rating. No critical category shall exist for grades.

Grade	Code
Good (0-3%)	1
Fair (3-6%)	2
Poor (over 6%)	3

(7) Safe Driving Speed, columns 61, 62, 63 and 64. The total length to the nearest tenth of a mile of the speed zones determined by the following criteria shall be recorded.

Safe Driving Speed	Column
30MPH and over	61 62
20-29 MPH	63 64

The following example illustrates the method of coding:

(a) 1.7 miles, 30 MPH and over

(b) 0.9 miles, 20-29 MPH

1	7	0	9
61	62	63	64

STATE HIGHWAY BRIDGE INVENTORY DATA SHEET

A separate I.B.M. card will be prepared for each bridge described on the bridge inventory data sheet (Form S-3). The identification information that appears on card No. 1 (columns 1 - 16) will be punched on each bridge inventory card by the I.B.M. machine. Do Not Fill in These Columns.

If the structure carries divided lane traffic, the structure shall be coded in the subsection which is found on the right. If two separate structures carry the separate lanes, the structure on the right shall be coded in the subsection on the right and the structure on the left shall be coded in the subsection on the left.

1) Structure Number, columns 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, and 27. The structure number shall be recorded directly as it is found on the bridge inventory data sheet. All dashes in the structure number shall be recorded on the I.B.M. multiple layout sheet and all blank columns shall be filled with number 0. If the structure number is not known, the number 0 shall appear in all columns. The following examples illustrate how the coding shall be done:

(a) Structure Number 30-M-35114A

(b) Structure Number 9-R-2501A

(c) Structure Number S-L-11-3742

3	0	-	M	-	3	5	1	1	4	A
0	0	9	-	R	-	2	5	0	1	A
S	-	L	-	1	1	-	3	7	4	2
17	18	19	20	21	22	23	24	25	26	27

The letter "O" shall be indicated with a bar: "Θ"; and the letter "i" shall be shown as "I".

2) Overall Length, columns 28, 29, 30, and 31. The overall length shall be indicated to the nearest foot. The following example illustrates how the recording shall be done:

(a) Structure length 1129'

(b) Structure length 27'

(c) Structure length 102'

1	1	2	9
0	0	2	7
0	1	0	2
28	29	30	31

3) Curb-toCurb Width, columns 32, 33. The curb-to-curb width shall be recorded to the nearest foot. The number "0" shall be placed in columns 32 and 33 when this item does not apply. The method of recording shall be done as illustrated:

(a) Curb-to-curb width 24

(b) Curb-to-curb width 30

2	4
3	0
32	33

4) Rail to Rail Width, columns 34 and 35. The rail to rail width shall be recorded to the nearest foot, as is illustrated under item 3, "Curb-to-Curb Width". Record 0 in columns 34 and 35 when this item does not apply.

5) Number of Spans, column 36. The number of spans shall be recorded in column 36. The number 9 shall indicate "9 or more" spans. The following example illustrates the method of coding:

(a) Bridge	10 spans	9
(b) Bridge	7 spans	7
(c) Bridge	1 span	1

6) Type of Superstructure, columns 37 and 38. The type of superstructure shall be recorded according to the following code:

Abbreviation	Key to Abbreviation	Code
St. Tr.	Steel Truss	1
St. Bm.	Steel Beam	2
Cont. St. Bm.	Continuous Steel Beam	3
St. Gir.	Steel Girder	4
Pl. Gir.	Steel Plate Girder	5
Enc. I's	Encased I Beams	6
R.C.A.	Reinforced Concrete Arch	7
Unreinf. Conc. A.	Unreinforced Concrete Arch	8
Stone A.	Stone Arch	9
R.C.G.	Reinforced Concrete Girder	10
R.C.S.	Reinforced Concrete Slab	11
Cont. R. C. S.	Continuous Reinforced Concrete S...	12
O.S.	Open Spandrel	13
Ped. UP	Pedestrian Underpass	14
Cov. Tim. Tr.	Covered Timber Truss	15
T.B.	Temporary Bridge	16
Mult. Pl. A.	Multiple Plate Arch	17
U.P.	Underpass	18
T.T.	Timber Trestle	19

7) Material in Superstructure, column 39. The material in the bridge superstructure shall be coded as follows:

Material	Code
Steel	1
Wood	2
Reinforced Concrete or Masonry	3
Steel and Reinforced Concrete	4
Wood and Reinforced Concrete	5
Wood and Steel	6

8) Vertical Clearance, columns 40, 41, and 42. Enter the minimum vertical clearance from the highway roadway to the lowest point of overhead obstruction. If no overhead obstruction exists, fill in columns 40, 41, and 42 with the number 0. The following example illustrates how this item shall be recorded:

(a) Vertical clearance 14'-6"
(b) " " 11'-3"
(c) " " 13'-2"

1	4	6
1	1	3
1	3	2
40	41	42

9) Condition of the Superstructure, column 43. The condition of the superstructure shall be classified and coded according to the following condition ratings:

Condition	Code
Good	1
Fair	2
Bad	3

10) Railing Type, column 44. Enter the type of railing in column 44 according to the following code:

Type of Railing	Code
None	0
Steel	1
Wood	2
Reinforced Concrete or masonry	3
Wood and Steel	4
Wood and Reinforced Concrete	5
Steel and Reinforced Concrete	6

11) Sidewalks - Left, column 45, Right, column 46. The width of sidewalk shall be recorded to the nearest foot on the left and right in columns 45 and 46, respectively. If no sidewalks exist the number "0" shall be recorded.

12) Type of Floor, column 47. The type of floor on the superstructure shall be classified and coded as follows:

Type of Floor	Code
Steel	1
Wood	2
Reinforced Concrete	3
Steel and Reinforced Concrete	4
Steel and Wood	5
Wood and Reinforced Concrete	6

13) Condition of Floor, column 48. The condition of the floor shall be rated and coded as follows:

Condition	Code
Good	1
Fair	2
Bad	3

14) Type of Substructure (abutment and piers), column 49. The type of the substructure shall be classified and coded as follows:

Type of Substructure	Code
Steel	1
Wood (Pile bents)	2
Reinforced Concrete or masonry	3
Steel and Reinforced Concrete	4
Wood and Reinforced Concrete	5
Wood and Steel	6

15) Condition of Substructure, column 50. The substructure condition shall be classified and coded as follows:

Condition	Code
Good	1
Fair	2
Bad	3

16) Condition of the Approaches, column 51. Classify and code the condition of the approaches as follows:

Condition	Code
Good	1
Fair	2
Bad	3

17) Clearance Above Stream Bed or Highway, columns 52, 53, and 54. Enter the clearance above the stream bed highway, or railroad to the nearest 0.1 of a foot. The following illustrates the method of coding. Record number 9 in three columns 52, 53, and 54 if the clearance is unknown. If this item does not apply record 8 in columns 52, 53 and 54.

(a) Height above stream bed 9.6'
(b) Height above railroad 13.1'
(c) Height above highway 14.3'

0	9	6
1	3	1
1	4	3
52	53	54

18) Clearance above High Water, columns 55 and 56. Indicate the clearance of the bridge (i.e., low steel or low concrete) above high water to the nearest foot. If the high water is higher than the bridge, record the height of the water over low steel or low concrete in columns 55 and 56 and place an "x" punch over the number in column 56. The following illustration indicates how the coding shall be done. Use number 9 in columns 55 and 56 if high water is unknown. If this item does not apply record 8 in columns 55 and 56.

(a) High water 2 feet above bridge
(b) High water 3 feet below bridge
(c) High water 11 feet below bridge

	x
0	2
0	3
1	1
55	56

19) Age of Structure, columns 57 and 58. The age of the structure in years shall be indicated. If the age of the structure is unknown, the number 9 shall be recorded in columns 57 and 58. The following illustrates the method of coding:

			57	58
(a)	Structure	25 years old.	2	5
(b)	"	1 year "	0	1
(c)	Age Unknown		9	9

20) Estimated Safe Load (tons), columns 59 and 60. The safe load shall be recorded as it appears on form S-3. The safe loading, whichever is the lowest indicated, may be a posted load, an estimation of the safe load by the engineer who made the inventory, or the design loading of the bridge as is shown on the plans for the structure. Record number 9 in columns 59 and 60 if safe load is unknown. Record "20" is blank is filled by mix.

21) Service, column 61. The service provided by the structure shall be classified and coded as follows:

Service	Code
Stream Crossing	1
Highway Separation	2
Railroad Over Highway	3
Railroad Under Highway	4
Stream Crossing and railroad separation	5
Stream Crossing and highway separation	6
Highway and Railroad separation	7
Railroad over highway and stream	8

STATE HIGHWAY RAILROAD PROTECTION DATA SHEET

A separate I.B.M. card will be prepared for each railroad crossing in each subsection and as described on the State Highway Railroad Protection Data Sheet (Form S-4). The identification information that appears on card No. 1 (columns 1 - 16) will be punched on each railroad crossing inventory card by the I.B.M. machine. Do Not Fill In These Columns.

1) Number of trains per day, columns 17 and 18. Record the number of trains per day in columns 17 and 18. If the number of trains is 99 or more record number 99. The following example illustrates the method of coding:

(a)	Number of trains	2	0	2
(b)	" " "	23	2	3
(c)	" " "	104	9	9
			17	18

2) Number of main tracks, column 19. The total number of main line tracks shall be recorded. The number 9 shall indicate "9 or more" main line tracks.

3) Number of siding or other tracks, column 20. The total number of siding or other tracks shall be recorded. The number 9 shall indicate "9 or more" tracks.

4) Approximate Speed of Passenger Trains, columns 21 and 22. Approximate speed of passenger trains in miles per hour shall be recorded. If no passenger trains use the tracks, record 0 in columns 21 and 22.

5) Approximate Speed of Freight Trains, columns 23 and 24. Record the approximate speed of the freight train in miles per hour. If no freight trains use the tracks, record 0 in columns 23 and 24.

6) Type of protection, column 25. The type of protection shall be coded according to the following classifications:

Classification	Code
Signals and Short Arm Gates	1
Signals and signs	2
Signs only	3

7) Condition and Location of Protection Devices, column 26. The protection devices shall be classified and coded as follows:

Location and Condition	Code
Good	1
Fair	2
Bad	3

8) Angle of crossing, columns 27 and 28. The angle of crossing formed by the intersection of the center line of the highway with the railroad shall be indicated to the nearest degree. Always record the supplement of the angle which is 90 degrees or less. The following indicates the method of recording this information:

(a)	Angle of crossing	102°
(b)	" " "	65°
(c)	" " "	51°

7	8
6	5
5	1
27	28

9) Sight Distance 300 feet from track, Far column 29, Near column 30 The far and near sight distance for 300 feet from the tracks shall be classified and coded as follows:

Classification	Code
Good	1
Fair	2
Bad	3

10) Condition of the Approaches, Far column 31, Near column 32. The condition of the approaches shall be classified and coded according to the following:

Condition of Approaches	Code
Good	1
Fair	2
Bad	3

11) Condition of Crossing, column 33. The condition of the crossing shall be classified and coded according to the following method:

Condition of Crossing	Code
Good	1
Fair	2
Bad	3

12) Feasibility of Grade Separation, column 34. Feasibility of a grade separation shall be classified and coded according to the following method:

Feasibility	Code
None	1
By underpass	2
By overpass	3
By relocation	4
By relocation and underpass	5
By relocation and overpass	6

13) Name of Railroad, columns 35 and 36. The name of the railroad shall be coded as follows:

Class I Roads	Code
Baltimore & Ohio R. R.	01
Chesepeake & Ohio R. R.	02
Chicago & Eastern Illinois Ry.	03
Chicago, Indianapolis & Louisville Ry. (Monon)	04
Chicago, Milwaukee, St. Paul and Pacific R. R	05
Elgin, Joliet & Eastern Ry.	06
Erie R. R.	07
Grand Trunk Western R. R.	08
Illinois Central R. R.	09
Louisville and Nashville R. R.	10
New York Central R. R.	11
New York, Chicago & St. Louis R. R. (Nickel Plate)	12
Pennsylvania R. R.	13
Southern Ry.	14
Wabash R. R.	15

Class II Roads	
Algers, Winslow & Western Ry.	16
Central Indiana Ry.	17
New Jersey, Indiana & Illinois R. R.	18
Southern Indiana Ry. Inc.	19

Class III Roads	
Louisville, New Albany & Corydon R. R.	20
Twin Branch R. R.	21

Switching and Terminal Companies	Code
Baltimore & Ohio Chicago Terminal R. R.	22
Chicago Short Line Ry.	23
Fort Wayne Union Ry.	24
Indiana Harbor Belt R. R.	25
Indiana Northern Ry.	26
Indianapolis Union Ry.	27
Kentucky & Indiana Terminal R. R.	28
Lake Erie and Fort Wayne, R. R.	29
Louisville & Jeffersonville Bridge R. R.	30
Muncie & Western R. R	31

Where more than one company uses the same crossing, the company highest in above order will be coded and an "X" marked in column 36

14) Average Daily Traffic Volume, Columns 37, 38, 39, 40, and 41. Enter the average daily traffic volume for the highway as is illustrated by the following example:

(a) 11200 vehicles per day
(b) 1920 " " "
(c) 120 " " "

1	1	2	0	0
0	1	9	2	0
0	0	1	2	0
37	38	39	40	41

I.B.M. MULTIPLE CARD LAYOUT PROJECT NEEDS STUDY DATE ______

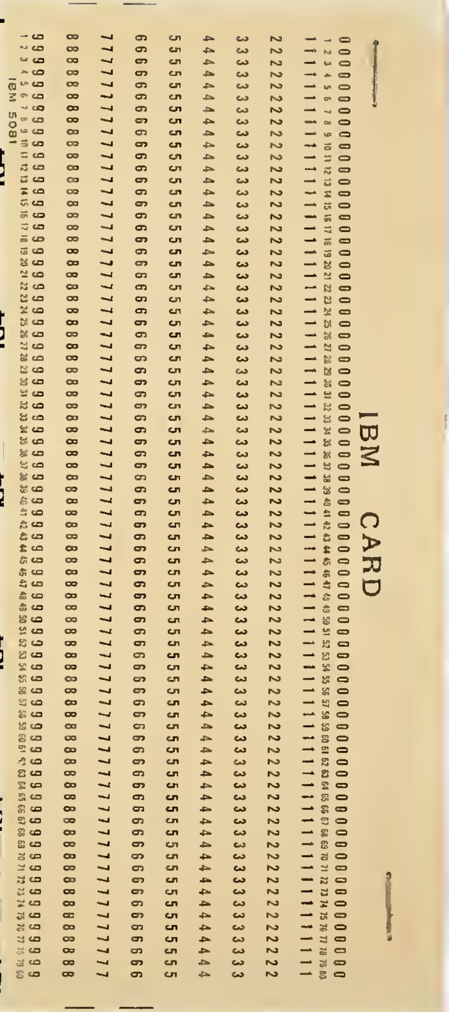
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64